NOAA Project Final Report

I. **Title**: The Effectiveness of Bycatch Reduction Devices on Crab Pots at Reducing Capture and Mortality of Diamondback Terrapins and Enhancing Capture of Blue Crabs

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II. Abstract

We tested the efficacy of a bycatch reduction device (BRD) to prevent diamondback terrapins from entering and drowning in crab pots. We tested the devices in eight Florida counties over a period of four years. We used 15 unaltered crab pots (controls) and 15 crab pots with the BRDs (experimentals). We found that 73.2% of terrapins in our study could have been prevented from entering crab pots if BRDs were in use. In comparing crab catch between control and experimental pots, we found no statistically significant difference in the number, size, or sex of crabs captured. We recommend to the Florida Fish and Wildlife Conservation Commission that BRDs be required on all crab pots fished in Florida waters.

III. Executive Summary

Diamondback terrapins (*Malaclemys terrapin*) drown in blue crab (*Callinectes sapidus*) pots throughout their range. The objectives of this study were to: 1) test if bycatch mortality of diamondback terrapins in commercial crab pots is reduced by using bycatch reduction devices; 2) determine if bycatch reduction devices affect crab catch in Florida by comparing sex, size, and number of blue crabs captured in standard crab pots with those captured in pots equipped with bycatch reduction devices; and 3) formulate recommendations to the Florida Fish and Wildlife Conservation Commission for regulations that reduce terrapin bycatch mortality in Florida waters. We fished 15 standard crab pots (controls) and 15 crab pots with bycatch reduction devices (experimentals) for 10-day periods at two sites per year from 2002 through 2005. Study sites were located in eight Florida counties with one sample period per county. Pots were checked daily and baited on alternate days. We determined sex of all captured terrapins and blue crabs and took measurements of each that would allow us to evaluate if bycatch reduction devices affected the size of either species. Thirty-seven terrapins were caught in control pots and four in experimentals. Several were small enough that they would not have been prevented from entering either pot treatment, but we found that 73.2% of the terrapins in this study could have been prevented from entering crab pots with functional bycatch reduction devices. There were no significant differences between the sex, measurements, or number of legal-sized crabs captured in control and experimental pots at any of the study sites. We recommend that the Florida Fish and Wildlife Conservation Commission devise and adopt regulations that require the

use of 4.5 x 12 cm bycatch reduction devices on all commercial and recreational crab pots in Florida without delay.

IV. Purpose

A. Description of the problem that was addressed.

Diamondback terrapins (*Malaclemys terrapin*) are the only turtles entirely restricted to brackish water habitats of the Atlantic and Gulf coasts of the United States, and range from Cape Cod, Massachusetts to Corpus Christi, Texas (Ernst et al. 1994). They share this ecosystem with blue crabs (*Callinectes sapidus*), and terrapin mortality due to bycatch in crab pots has been known for over 60 years (Davis 1942). At a 2004 workshop on terrapin biology, specialists agreed that mortality due to bycatch in crab pots is the greatest threat to terrapin populations throughout their range (J. Butler, G. Heinrich, R. Seigel, unpublished data).

Roosenburg (2004) provided a comprehensive review of the impact of blue crab fisheries on terrapin populations. Terrapin bycatch mortality has been reported from New Jersey (Burger 1989; Mazzarella 1994; Wood and Herlands 1996; Wood 1997), Delaware (Cole and Helser 2001), Maryland (Roosenburg et al. 1997; Roosenburg and Green 2000), South Carolina (Bishop 1983; Hoyle and Gibbons 2000), Florida (Butler 2000; 2002), Alabama (Marion 1986), Mississippi (Mann 1995), and Louisiana (Guillory and Prejean 1998). Capture rates are difficult to compare among these projects due to variation in methods, equipment, terrapin population densities, habitats, and study goals. However, rates from 0.027 - 0.49 terrapins $\cdot$ pot^{-1} $\cdot$ day^{-1} have been reported (Bishop 1983; Mann 1995; Roosenburg et al. 1997; Wood 1997; Hoyle and Gibbons 2000). Mortality estimates due to crab pots are also difficult to compare, but they vary from 1,759 terrapins killed per year (estimated from data collected in April and May) in South Carolina (Bishop 1983), to 17,748 - 88,740 per year in New Jersey (Wood and Herlands 1996), and between 15% and 78% of the population per year in the Chesapeake Bay (Roosenburg et al. 1997). Terrapins exhibit a high degree of site fidelity (Lovich and Gibbons 1990), and such high capture and mortality rates can quickly decimate local populations.

The terrapin bycatch mortality problem is sometimes compounded, as these gregarious turtles often follow one another into pots, and we have captured from two to five individuals in a single active pot (Butler 2000; 2002). This situation can be further exacerbated by ghost pots, which are those pots that are either lost or abandoned by trappers but still trap animals. Bishop (1983) found 28 decomposing terrapins in one ghost pot and Roosenburg (1991) discovered 49 in another.

Wood (1997) designed bycatch reduction devices (BRDs) and demonstrated their efficacy in decreasing terrapin bycatch in crab pots. The devices are composed of wire or plastic rectangles attached to the inside opening of each entrance funnel of the pot. The height of the rectangle impedes the entrance of larger turtles, without significantly reducing crab capture. Roosenburg and Green (2000) refined the technique by testing a variety of BRD dimensions and determining the size that would exclude most terrapins while capturing most crabs. To date, three studies of BRDs have reported increased capture of legal-sized blue crabs in pots with BRDs, and the

authors suggested that once crabs enter traps, the limited funnel size inhibits their escape (Wood 1997; Guillory and Prejean 1998; Roosenburg and Green 2000).

The coastline of Florida represents over 20% of the entire terrapin range, thus the impact of crab pot mortality in this state has great significance, not only to Florida terrapins but to the conservation of the entire species. The Florida Fish and Wildlife Conservation Commission (FFWCC) is concerned about terrapin bycatch, but asserts that data from Florida are necessary before management recommendations concerning the use of BRDs can be developed in the state. This project tested the efficacy of BRDs on crab pots in eight coastal counties of Florida.

B. Objectives of the Project

1) To test if bycatch mortality of diamondback terrapins in commercial crab pots is reduced by using BRDs;

2) To determine if BRDs affect crab catch in Florida by comparing sex, size, and number of blue crabs captured in standard crab pots with those captured in pots equipped with BRDs;

3) To formulate recommendations to the FFWCC for regulations that reduce terrapin bycatch mortality in Florida waters.

V. Approach

A. Description of the work

Thirty-five of Florida's 67 counties have coastal borders with appropriate habitats for both diamondback terrapins and blue crabs. We chose eight counties in an attempt to represent a diversity of regions and habitats throughout the state. The presence of terrapins in each study area was confirmed by prior reconnaissance. In 2002, we worked in Casa Cola and Jackson creeks (CC, JC) in St. Johns and Nassau counties respectively. These northeastern sites were creeks emptying into the Intracoastal Waterway in typical salt marsh habitat with cordgrass (*Spartina* sp.) and black needlerush (*Juncus roemerianus*) predominating. In 2003, we trapped at Alafia Bank (AB) which includes Sunken and Bird islands at the mouth of the Alafia River in Hillsborough County, and at Critical Bayou (CB) adjacent to Terra Ceia Bay in Manatee County. Both Tampa Bay sites had red, white, and black mangrove (*Rhizophora mangle, Laguncularia racemosa,* and *Avicennia germinans* respectively) along shorelines, and the CB site was populated with turtle grass (*Thalassia testudinum*). In 2004, we placed pots in Oyster Bay (OB) around Gull, Smith, and Palmetto islands in Wakulla County, and in Tyre Creek and other areas west of the causeway (SR 24) to Cedar Key (CK) between the Number 3 and 4 channels in Levy County. In both locations, cordgrass and black needlerush were present on the numerous islands, and in Cedar Key, red mangrove and the invasive non-native Brazilian pepper (*Schinus terebinthifolius*) were present. In 2005, we set pots in Florida Bay (FB) in the Key Largo area around Pigeon Key and in the southeastern part of Lake Surprise in Monroe County, and in the Banana River (BR) near the southern end of Horti Point and on the eastern shoreline in the Thousand Islands in Brevard County. We noted the three mangrove species and Brazilian

pepper at both sites, and another invasive non-native species, Australian pine (*Casuarina* sp.), was prevalent in the Brevard County study area.

Preliminary studies between 1995 and 2000 using various modified crab pots in northeastern Florida suggested that terrapins entered the pots more frequently in May than in June or July (Butler 2000; 2002). Therefore, for this project we fished 30 crab pots for 10-day periods at two sites per year in the month of May from 2002 through 2005. Fifteen pots were equipped with BRDs (experimentals) and 15 were left unchanged (controls). Typical commercial crab pots have dimensions of 60 x 60 x 45 cm with entrance funnels in 4 sides. Each funnel is 12.5 cm long, with the outer opening being 12.5 x 17.5 cm, and the inner opening 10 x 15 cm. The BRDs we used are 4.5 x 12 cm rectangles made of 12 gauge galvanized steel wire (about the diameter of a coathanger). A single wire 37.5 cm long was molded to these dimensions such that one side was formed by overlapping two 4.5 cm ends of the wire. The ends forming this side were fastened together with galvanized steel j-clips. The BRDs were affixed to the inner openings of pot entrances with stainless steel hog rings to limit the funnel dimensions. Terrapins are dimorphic with females being quite larger than males, and the objective of the BRDs is to reduce the size of the opening to impede adult female terrapins and the largest males from entering pots while not decreasing crab capture. Small male terrapins and immature females would still be able to enter the pots, but because males often follow mature females into pots, this methodology could secondarily reduce male entrapment.

Crab pots were placed in rows of alternating experimental and control treatments approximately 20 m from one another. All pots were checked daily and baited on alternate days. We used baits recommended by local crab trappers, and at most sites (JC, CK, FB, and BR) that was pogy (menhaden, *Brevoortia* sp.). At CC we used fish market discards, at AB and CB we used shad (*Alosa* sp.), and in OB we used chicken backs. Control pot data represented the expected capture numbers and sizes of both terrapins and crabs under normal circumstances, and those values were compared to capture totals for experimental traps.

We sexed all captured terrapins, and measured shell height (SH) and carapace width (CW) with calipers (1 mm). Though not critical to this study, we also weighed the terrapins with hand-held Pesola scales (5 g) and measured carapace and plastron lengths (CL, PL). All live specimens were released at the capture sites. To monitor whether terrapins were recaptured during the study, each was injected between the carapace and the right hind limb with a unique subcutaneous microchip (12 mm, AVID Identification Systems, Inc., Norco, CA). Terrapins that died as a result of entrapment were preserved and placed in the University of North Florida Vertebrate Zoology Collection.

All captured blue crabs were sexed, and we measured the distance between the lateral points of the carapace (point to point, PP) with calipers (1 mm) to determine if they were of legal size. Legal size for harvest of blue crabs in Florida is 5 in. (127 mm) PP, so all crabs smaller than this were released at the capture site. We also recorded the front to back measurement of the carapace (FB), and carapace height (CH) of most of the legal crabs. All legal-sized crabs were removed from the study area, so they would not be recaptured. Catch per unit effort (CPUE) was calculated as crabs $\cdot$ pot^{-1} $\cdot$ day^{-1}.

Statistical analyses were performed using SPSS 11. Numbers of crabs captured in control and experimental pots were compared at each site using the chi-square statistic. We used ANOVA to compare crab measurements with trap treatment and sex at each site. Significance level was 0.05. Means are followed by ± one standard error.

B. Project Management

- Joseph A. Butler, University of North Florida – Co-PI
- George L. Heinrich, Heinrich Ecological Services – Co-PI
- Charles Miller, St. Petersburg College – Student assistant
- Zach Mullin, University of North Florida – Student assistant
- Steve Valerio, University of North Florida – Student assistant
- Phillip Fain, Nassau County – Licensed crab trapper
- Gus Muench, Hillsborough County – Licensed crab trapper
- Keith Miller, Manatee County – Licensed crab trapper
- Monty Metcalf, Wakulla County – Licensed crab trapper
- Earl Brown, Levy County – Licensed crab trapper
- Mike Laudicina, Monroe County – Licensed crab trapper
- Mark Radler, Brevard County – Licensed crab trapper

VI. Findings

A. Actual accomplishments and findings

Terrapins

We captured 41 diamondback terrapins, 30 males and 11 females for a sex ratio of 2.7:1. Eleven males and three females died as a result of entrapment during the study. Fourteen other captured terrapins were unconscious or barely moving when found. These were kept overnight in buckets and all survived after up to 24 hours in captivity. No terrapins were recaptured. Multiple captures in the same pot of from two to four terrapins occurred five times. Mean terrapin CW was 90.8 ± 1.69 mm (range = 69 - 118 mm), and mean SH was 48.1 ± 0.84 mm (range = 39 - 68 mm).

Thirty-seven terrapins were captured in control pots and four in experimentals. Of the ones captured in experimental pots, three had SHs of less than 45 mm, and therefore were not prevented from entering with the size of BRDs we used. The fourth, captured during the second season, had a SH of 48 mm, and we determined that two BRDs on that pot had become misshapen to heights exceeding 45 mm. This event prompted us to recheck BRD measurements on all experimental pots, and we found this pot to be the only one with the problem. Of the 37 terrapins captured in control pots, five had SHs less than 45 mm, and three had SHs exactly 45 mm high. Therefore, we can say with certainty that 30 terrapins (73.2%) in this study (29 from controls and one from the non-functioning experimental) could have been prevented from entering crab pots with functional BRDs.

We captured no terrapins in CC, FB, or BR. In JC we captured three male and two female terrapins, all in control pots. We lost one of our control pots for the last five days at JC, so we

had 295 trap-days and our rate of terrapin capture there was 0.017 terrapins $\cdot$ pot^{-1} $\cdot$ day^{-1}. If we consider only control pots (145 trap-days), because large terrapins were naturally excluded from the experimental pots, then the terrapin capture rate was 0.034 terrapins $\cdot$ pot^{-1} $\cdot$ day^{-1}.

At AB we captured 22 terrapins in controls and one in an experimental pot (the misshapen one described above). Twenty-one were males and two were females. Capture rate there for 300 trap-days was 0.077 terrapins $\cdot$ pot^{-1} $\cdot$ day^{-1}, or considering only control pots 0.147 terrapins $\cdot$ pot^{-1} $\cdot$ day^{-1}. In CB we captured eight terrapins in controls and three in experimentals. Four were males and seven were females. Capture rates there were 0.037 terrapins $\cdot$ pot^{-1} $\cdot$ day^{-1} overall, or 0.053 terrapins $\cdot$ pot^{-1} $\cdot$ day^{-1} in controls only.

We captured one terrapin at OB and one at CK; both were males in control pots. Capture rate at each of those sites then was 0.003 terrapins $\cdot$ pot^{-1} $\cdot$ day^{-1}, or considering only control pots 0.007 terrapins $\cdot$ pot^{-1} $\cdot$ day^{-1}.

Crabs

We captured 2,753 legal-sized crabs, 1,906 males and 847 females. There were no significant differences between the numbers of legal-sized crabs captured in control and experimental pots at any of the study sites, and CPUEs were similar. At six sites (JC, AB, CB, OB, FB, and BR) significantly more males were trapped than females, but this was consistent for both pot treatments.

Trap treatment had no statistically significant effect on PP, CH, or FB of the crabs at any of the eight study sites. Female crabs had significantly larger point-to-point measurements than males at CC, JC, OB, and CK. Females had larger carapace heights than males at CB and OB; and at OB female front-to-back measurement was larger than that of males. In all cases these relationships were consistent for both pot treatments.

B. Problems

None of the problems encountered led to unsatisfactory or negative results. We found it necessary to “ground truth” reported terrapin sightings in areas we had never been to. This was not budgeted for in the original proposal and was quite expensive. By savings on other aspects of the project we were able to do these necessary visits.

C. Additional work

We believe that no additional field work is necessary before suggesting BRD regulations to FFWCC, as we have shown that BRDs reduce terrapin bycatch without affecting crab capture. Future endeavors will include assisting with the actual drafting of state regulations if we are included in this process.

VII. Evaluation

A. Attainment of project objectives

- Objective 1 – Our results documented a 73.2% reduction in trapped terrapins with the use of BRDs.
- Objective 2 – There were no significant differences in the number, size, or sex between crabs captured in experimental crab pots and those with BRDs.
- Objective 3 – Our results support a recommendation to require the use of BRDs on all crab pots in Florida waters. We have made initial contact with FFWCC officials and are determining the proper channels through which to accomplish this.

B. Dissemination of results

- Sent manuscript to the journal Conservation Biology for review for publication.
- Oral presentation at the Joint Meeting of Ichthyologists and Herpetologists in Tampa, 7 July 2005 – Effectiveness of bycatch reduction devices on crab pots at reducing diamondback terrapin capture and mortality.
- Oral presentation at the Third Workshop on the Ecology, Status, and Conservation of Diamondback Terrapins in Jacksonville, 17 September 2004 - Effectiveness of a bycatch reduction device on crab pots in Florida – preliminary results.

ADDENDUM

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